Space Weather Technical Forecast

Issued on Saturday, 27 April 2024 at 00:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Reducing risk of R, G and S-scale events during the four-day period.

Solar Activity: Solar activity as measured by GOES16 was Low in the past 24 hours, with a peak flare of C6.6 observed at 26/0636 UTC originating from AR3639 in the northwest. There are currently eight sunspot regions on the visible, one of which is unnumbered. The sunspot cluster in the southwest has now rotated just beyond the west limb. There are a few moderately sized sunspots on the disc, which are showing some minor developments. AR3654 near centre disc has shown some waxing and waning of its intermediate spots. AR3648 in the northwest, which is approaching the limb, has also shown minor growth within its intermediate spots. AR3658 in the southwest has shown development in its trailing spots. A new and unnumbered region has emerged in the northeast. The remaining sunspot regions are all relatively small, simple and stable.

The cadence of observed Coronal Mass Ejections (CMEs) remains relatively high on coronagraphs, although those observed in the period were either high latitude limb features or else far-sided. A filament and a prominence eruption were observed lifting off the southeast limb at 26/1830 UTC and produced a CME, which is currently under-going analysis for any potential Earth-directed component. Otherwise, no Earth-directed CMEs have been observed in coronagraph imagery in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have been at background, peaking at 387km/s at 26/0116 UTC, due to the weak arrival of a glancing CME (shortly after midnight), but despite this, solar winds have remained in a slow-regime throughout the period, steadily declining to near 330km/s at present. Density has been mostly below average, with a brief period of average values, between 26/1400-1900 UTC, before returning to below average values. The IMF, reached Moderate, peaking at 13nT at 26/1515 UTC, with the all-important north-south component, Bz, consistently negative, reaching -12nT at 26/1253 UTC. Phi angle was mostly negative (towards the Sun) at the start of the period, before re-orientating to mostly positive (away from the Sun) from 26/1500 UTC, probably due to a SSBC or CIR ahead of a HSS from CH27/+, although this is currently uncertain.

The net result of the above solar wind parameters started the period Quiet (Kp1-2), increasing to Unsettled to Active intervals (Kp3-4), with a period of G1/Minor Storm (Kp 5) observed between 26/1200-1800 UTC, probably due to the arrival of either a weak CME, or the CIR ahead of a HSS from CH27/+ or CH30/+, although this is uncertain at this stage.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was very slightly above Background levels (since 24/1400UTC) with the culprit most likely to be proton emission following southwestern quadrant M-class activity. High energy electron flux (greater than 2MeV) observed at GOES16 was initially at Moderate levels at the start of the period, with a peak of 348pfu at 26/0155 UTC, before declining to background levels, likely the result of minor CME influence. The associated 24-hour fluence remained below Active

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(1e8 integrated flux), with a declining trend since the arrival of the CME, with a peak during the period of near the 3.51e7 integrated pfu seen at 27/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: The X-ray forecast should see decreasing risks overall into the coming UTC weekend, as the cluster of southwestern regions more fully rotates off the facing side. Likely M-class activity should fall to a Chance during this time, with X-class showing a similar decrease within a Slight Chance.

Solar Wind / Geomagnetic Activity: There is now a reduced risk of further minor CME influence during the first half of the four-day period after the passage of a minor transient in the current UTC day. Any CME may combine with the CIR leading CH27/+ into the coming UTC weekend to perhaps give a peak Slight Chance of G1/Minor Storm as a result. From here, the chances of further such incidences should fall, with solar winds emanating from lower solar latitude CH29/+ and CH30/+ perhaps glancing Earth into the new UTC week. The result is that more reliably Quiet geomagnetic conditions should develop later in the period.

Energetic Particles / Solar Radiation: High energy proton flux is likely to remain at Background levels, but with a daily Slight Chance of reaching the S1/Minor Radiation Storm threshold now judged to gradually reduce later in the four days with the continuing passage of the southwestern cluster of sunspot groups onto the far side.

High energy electron flux is likely to be suppressed at GEO by minor anticipated CME and fast wind arrivals during the period. While a degree of recovery is likely into the new UTC week, the expected relatively small scale of inbound features may mean that the associated 24-hour electron fluence only has a Slight Chance of reaching similar highs to those seen on Thursday 25 April by the end of the four days.

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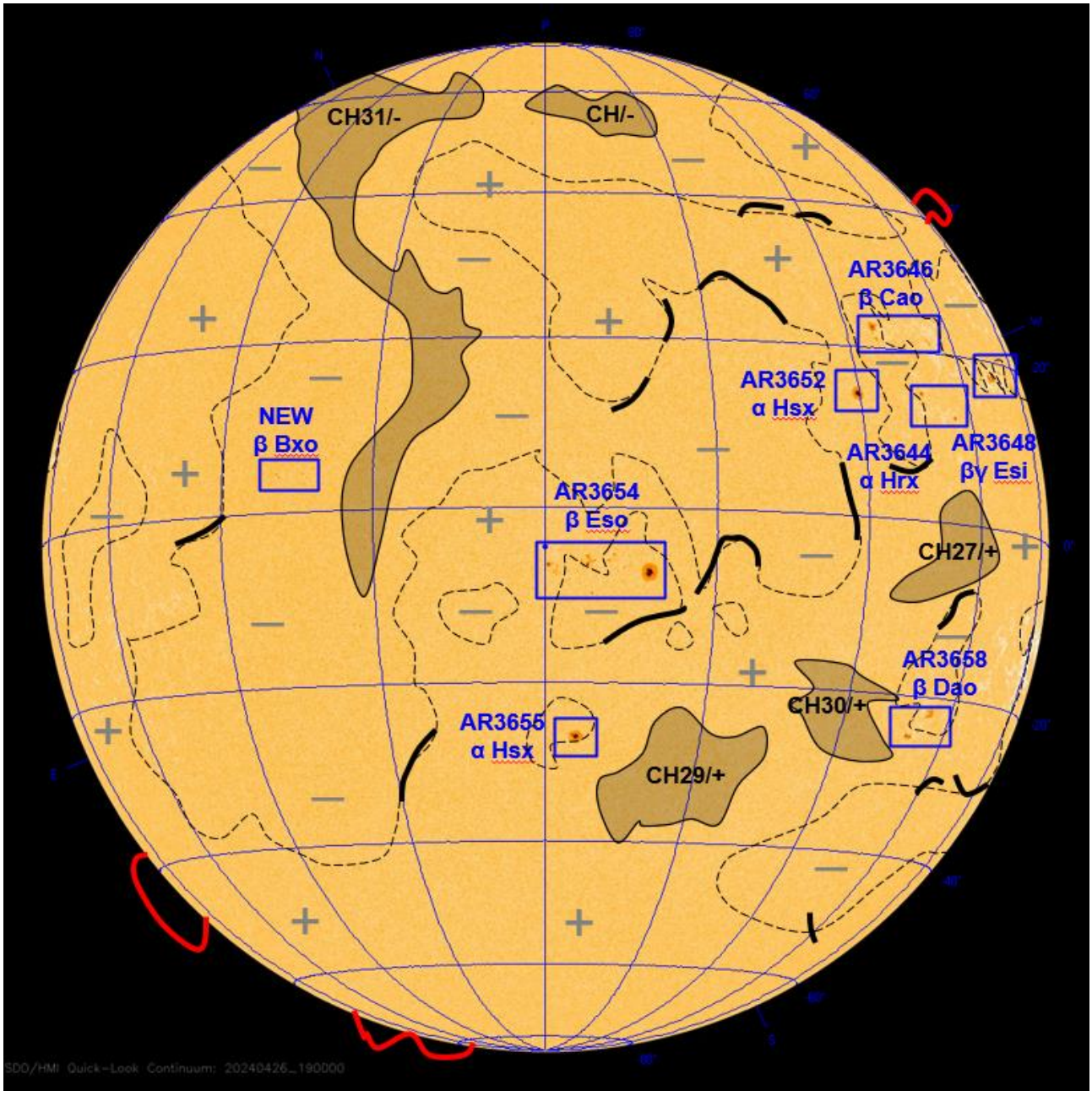
Figure 1. Solar Analysis Valid 26/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The risk of G-scale events is considered both 'low' and 'lowering' for the period as a whole, and is largely an expression of reduced confidence at first (as much as any expectation of G1 activity). This is the result of numerous CMEs released in the past week or so from regions such as Ex-AR3638, which is now sufficiently far west as not to further add to the tally of inbound CME glances. One such CME arrived in the previous 24-hour period, however it is not possible to ascribe this to any one outstanding event and remove it from MOSWOC Enlil, and the risk remains generalised for the next 24 hours or so of further such minor arrivals.

The fast wind-based forecast is of slightly higher confidence compared to the transient story, with a train of successive coronal holes in the form of CH27, 29 and 30 perhaps making themselves felt in the period, with a successively reducing likelihood as they lie progressively further south on the disc and further from the ecliptic plane. These are persistent features, with the leading edge of CH27/+ perhaps a little ahead of the previous rotation, and in this regard MOSWOC Enlil perhaps remains a little too slow to show its influence. Speeds arising from this feature may reach Elevated levels of 500-550 km/s based on the previous rotation, however, in part because of the polarity being positive, impacts are most likely expected to be muted.

All considered, the main risk of a Slight Chance of G1 will most likely be tied to the ongoing negative Bz period with the overnight UTC CME arrival, perhaps bolstered by any influence from any CIR leading CH27, and any further minor CME glances. All of these aspects should become less likely as the UTC weekend develops, such that the chances of further Active or G1 intervals become low into the new working week, barring new developments.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	20	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

MOSWOC Enlil still has a now much-reduced number of CMEs with minor glancing components of Earth due inside the first two UTC days of this period, although the most likely state of affairs is for these to miss.

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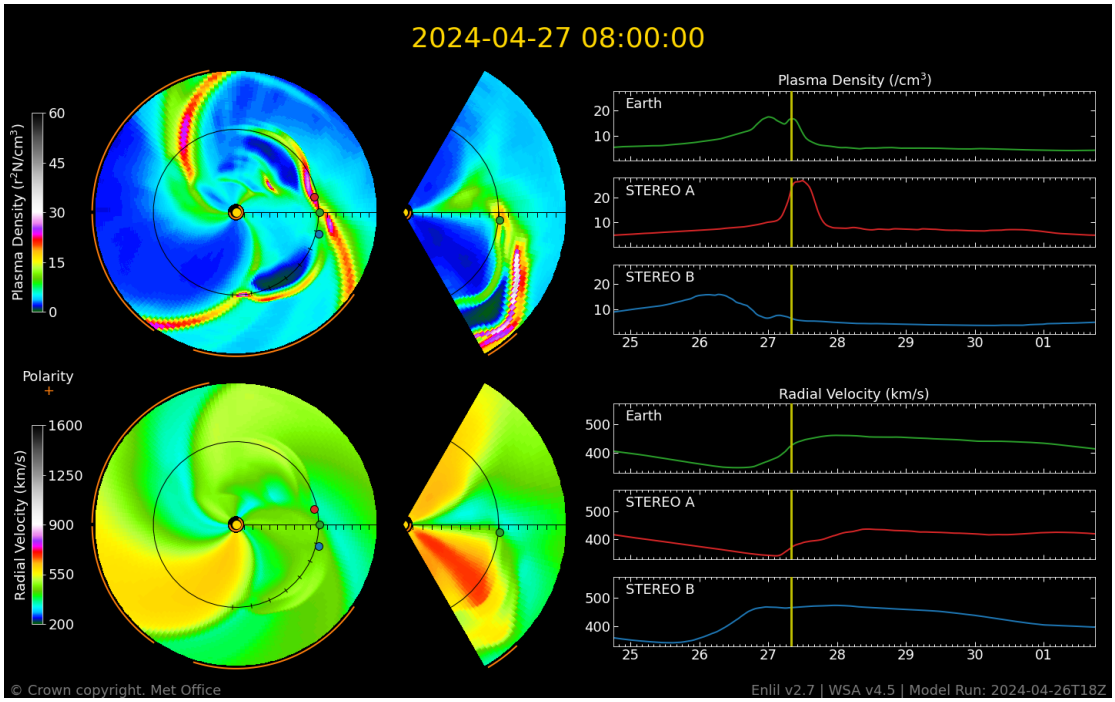
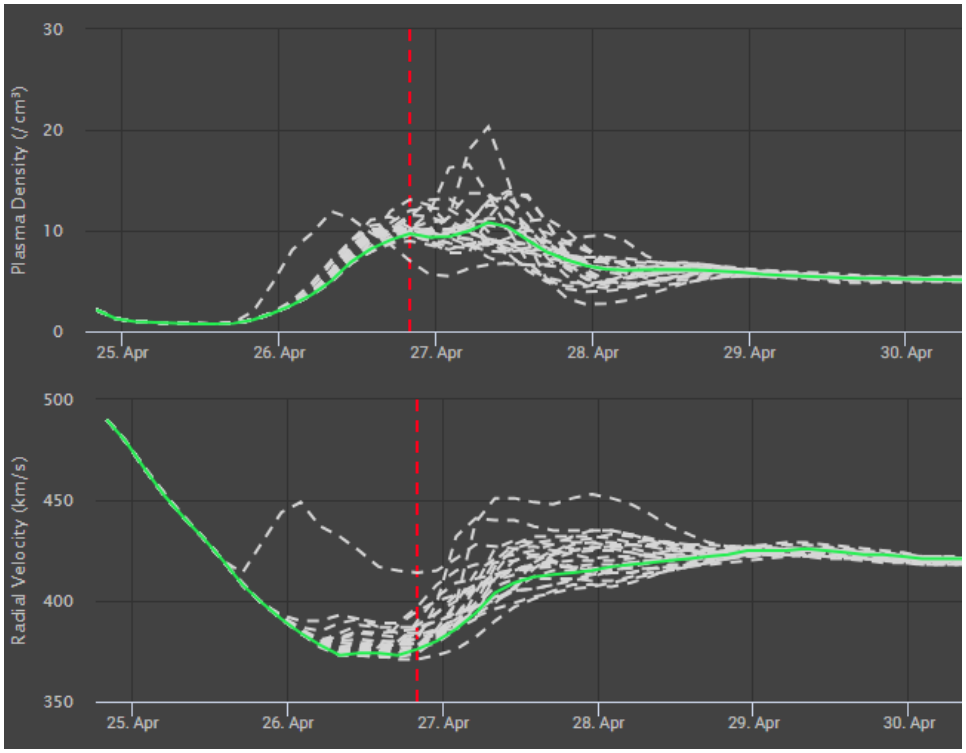
Figure 2: MOSWOC Enlil and ensemble – shows potential for a glancing CME during the current UTC day. The timing and presence of this feature is low confidence.





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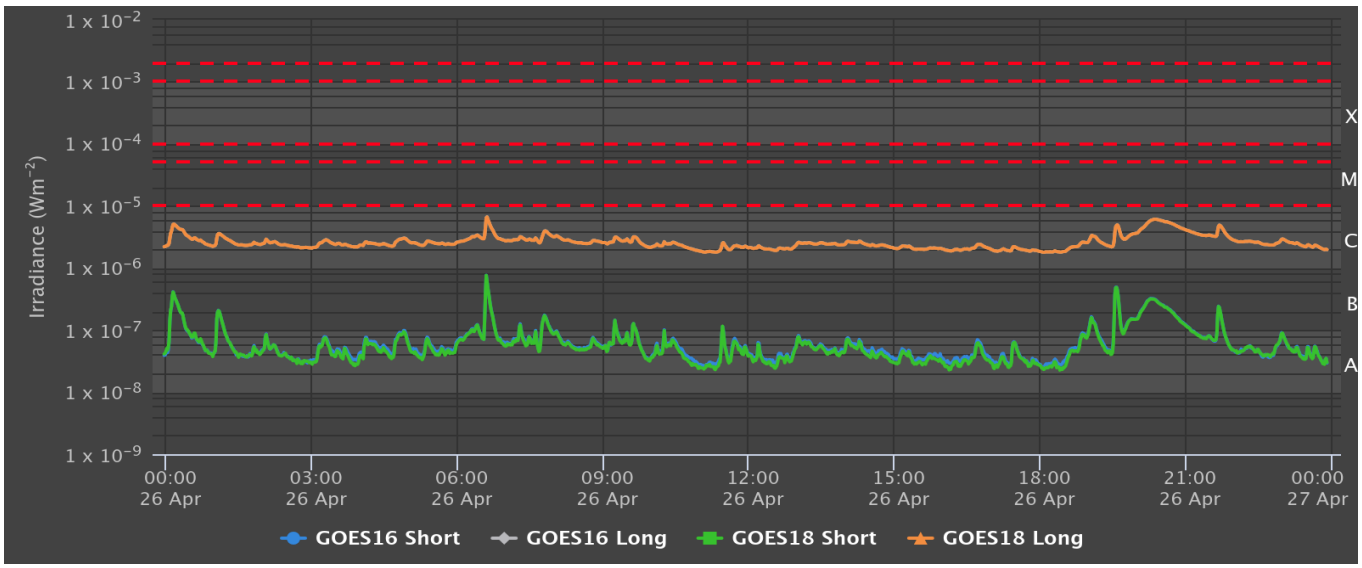
Radio Blackouts - X-Ray Flares:
The Earth-facing disc is now de-populating relative to the recent past, with numerous large and complex regions having rotated off the western limb, or positioned just beyond. This process should be complete to a large degree into the second half of the UTC weekend, leading to the risk of further M-class activity falling from Likely to a Slight Chance, while X-class shows a similar decline within Slight Chance.

Far-side helioseismographs show a relatively large signal covering a large portion of the far-sided eastern hemisphere, although there is relatively little expected in this location from persistence. This remains something to be monitored for any increase later in the four days, however for now a watching brief is maintained, and the flare risk is overall decidedly directed downwards.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	50	30	20	20
Very Active	R3 to R5 X Class	No	15	10	5	5

Figure 3: GOES18 X-Ray flux trace



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES18 was very slightly above Background levels (since 24/1400UTC) with the culprit most likely to be proton emission following the southwest quadrant M-class activity. Even at peak this registered at fractions of a pfu (where 10pfu is S1).

In terms of ongoing risk, care must be taken to account for the now-invisible population of spots lying on or near the southwestern limb, however the overall trend is considered to be a downward risk through a daily Slight Chance of S1 with the continuing passage of the southwestern cluster of sunspot groups onto the far side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux is likely to be continue to be suppressed at GEO by minor anticipated CME and fast wind arrivals during the period. Any further arrivals/passages are expected to become less obliquely aimed at Earth with time, and the greatest risk of any further dents to the population seen by GOES16 comes in the first 24 hours or so, with CH27 nearest the ecliptic (of the three minor coronal holes at suitable solar longitudes to arrive in the period, CH27, 30 and 29) and with any residual CMEs from the recent spate of activity most likely to cross 1AU.

While a degree of recovery is likely into the new UTC week, the expected relatively small scale of inbound features may mean that the associated 24-hour electron fluence only has a Slight Chance of reaching similar highs to those seen on Thursday 25 April by the end of the four days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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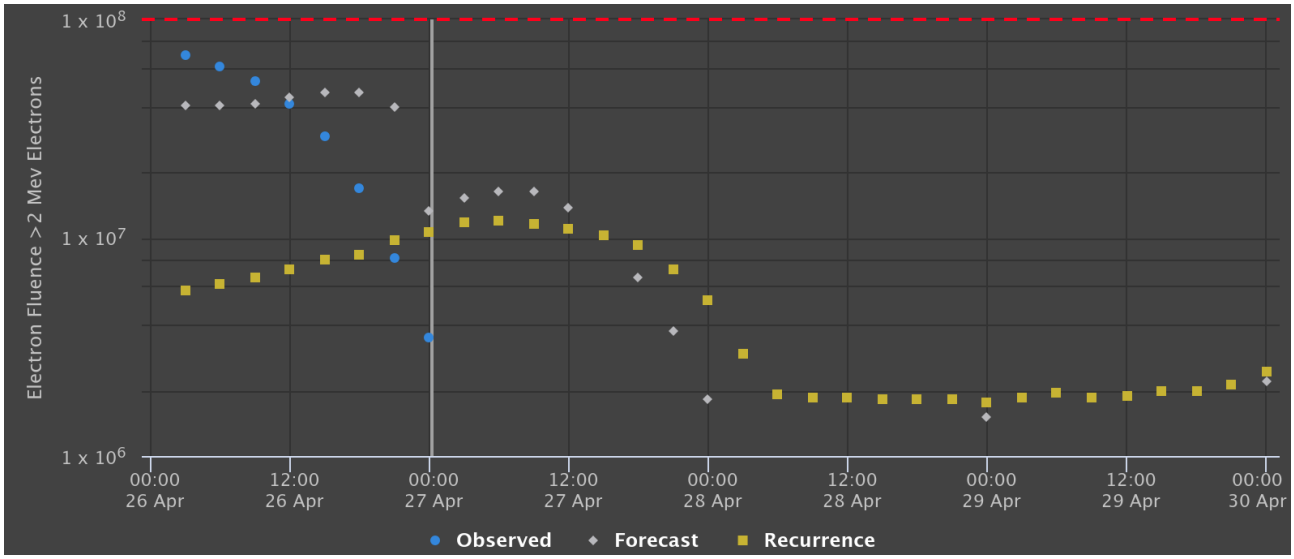
Figure 4: MOSWOC REFM electron fluence.



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